Comments Regarding:

Draft Guidance For Evaluating The Vapor Intrusion to Indoor Air Pathway From Groundwater And Soils (Subsurface Vapor Intrusion Guidance)

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INTRODUCTION

These comments pertaining to the "Draft Guidance For Evaluating The Vapor Intrusion to Indoor Air Pathway From Groundwater And Soil" (herein referred to as the "Draft Guidance") are submitted pursuant to the notice published in the Federal Register, November 29, 2002.

Comment No. 1

The Draft Guidance relies heavily on vapor intrusion models, e.g., the Johnson and Ettinger Model (JEM) [1] and ASTM E1739-95[2], which are themselves fundamentally flawed. The models greatly oversimplify the built structure and lack precision with respect to excessive predictions of false negatives; i.e., structures are predicted with an incomplete exposure pathway, or chemical contaminants are predicted to be below an action level; when structure-specific testing results in chemical concentrations detected above the action level due to an exposure pathway. Several researchers using the above-mentioned vapor intrusion models have demonstrated this phenomenon. [3,4,5,6,7] These studies also show that the models predict a significant percentage of false-positives. If air sampling were deemed necessary based on a

large percentage of false-positive predictions, resources would be wasted in sampling locations where insignificant exposure is occurring.

These models, relied upon and referenced by the Draft Guidance, were developed to evaluate residential structures. The models' theories, assumptions, and calculations were adopted from earlier studies where a very limited number of residential structures, in very limited settings, were researched and tested. In those earlier studies, the researchers had to assume many factors relevant to the built structure, including the fact that "typical" detached single-family dwellings would behave similarly. The author takes exception to many of those assumptions. With 15 years of experience in construction, and 15 years working as an environmental engineer who samples vapors in buildings, the author has been involved in the construction of thousands of detached single-family dwellings (SFD), hundreds of multi-family structures, and hundreds of commercial, retail, and industrial buildings. It is this author's opinion that built structures are anything but simple and typical, and do not behave similarly to chemical vapor intrusion, even if they generally appear similar. Structures vary significantly in complexity, form, setting, and use, and cannot be predicted with any precision, using overly simplified models. The author agrees that the referenced models will predict, more probably than not, a large percentage of possibly compromised structures when site-specific data are used versus (model) default parameters. However, it is the significant number of false-negatives and positives that the validation studies are identifying which are a matter of concern. The author agrees in concept with attempts to model a very complex set of parameters in order to predict possible chemical exposure to building occupants, and therefore to limit injury. However, based on model validation studies as well as the aforementioned construction and sampling experience, the precision of modeling vapor intrusion should be improved prior to its adoption by the EPA.

Comment No. 2

Page 5 of the Draft Guidance refers to odors as an "aesthetic" problem. Odors are a nuisance problem, not an aesthetic one.

Comment No. 3

Page 22 of the Draft Guidance, Secondary Screening – Question No. 4: Are indoor air quality data available?

This question assumes that the data are reliable, and this may not always be the case. For example, the Colorado site so often referred to in the Draft Guidance had air sample data. However, the initial set of air samples were collected in the summer months, during warm weather periods, and many residential units showed no significant exposure. Building occupants, especially residential users, typically have windows open and furnaces off during warm weather. These building use patterns significantly affect the concentration of indoor chemical vapors inside the built structure; whether from background sources or soil-gas vapor intrusion. Subsequent sampling in Colorado identified occupant exposure during wintertime conditions.

For many chemicals identified in the Draft Guidance, collecting and analyzing air samples to the published detection limits needed to quantify cancer risk, which is expensive. Collecting a sufficient number of samples to provide a statistically valid trend of indoor air contaminants is very expensive indeed. Due to cost considerations, most sampling efforts collect fewer of these types of samples than may be typically collected using other means -- albeit at a higher level of detection-- because the client typically wants to limit the expense(a valid concern). This tends to lead to limited data sets, which typically cannot adequately characterize indoor air quality. The Colorado study, for example, initially relied on one 24-hour SUMMA sample per residential unit. Based on Question No. 4(b), the screening exercise might stop (i.e., the pathway is incomplete) if sampling data did not detect constituents that exceeded target concentrations. The issues regarding data quality (discussed piecemeal in the Draft Guidance) must be brought forward and emphasized in the screening criteria, if site-specific air monitoring data are considered in pathway determinations.

Comment No. 4

Throughout the Draft Guidance, discussions regarding groundwater sampling, soil sampling, and soil-gas sampling are mentioned. Most of the criteria rely on groundwater and soil-gas sampling. In this author's opinion, the presence of chemicals in groundwater and soil are relevant to soil-gas vapor intrusion, but only slightly so. The presence and concentration of chemical vapors in the soil pore space (i.e., soil-gas) is of principal value and relevance. Results of soil-gas sampling under or near a structure are of specific relevance to predicting possible vapor intrusion into the structure. Why does the EPA continue to consider groundwater sample data beyond the Tier 1 screening level, when it is the vaporous chemicals that are most relevant to vapor intrusion?

The author recommends that groundwater and soil sampling data only be used in the Tier 1 – Primary Screening Stage in order to predict potential impacts to the built structure. Beyond that, only soil-gas sampling should be used to predict the probability of vapor intrusion.

Comment No. 5

The Draft Guidance appears to dabble in the science of construction. Many assumptions used in vapor intrusion models, specific questions in the Draft Guidance, and the basis for those questions are factors relevant to the art and science of the built structure (e.g., building ventilation rates, foundation design, building pressurization, evaluating building characteristics, etc.) The author recommends that the EPA engage the construction community in the development and use of the Draft Guidance. Scientists don't build structures; architects, engineers, and contractors do. Moreover, scientists are not well qualified to evaluate architectural components (e.g., foundation integrity), yet many construction professionals can provide this service. Appendix E of the Draft Guidance, for example, provides a list of guidance documents to be considered when characterizing the site, including sample collection and analysis, yet this appendix does not include any reference to construction science or structure evaluation. There is a wealth of information regarding the built structure, relevant to vapor intrusion modeling/prediction, of which the scientific community is not aware or is not using. If the construction community were included in the

development of the Draft Guidance, it would improve the precision of this guidance, and therefore its usefulness.

Comment No. 6

Page E-5 of the Draft Guidance discusses criteria recommended by the EPA for collecting air samples in residential structures(e.g., closing up the house for 12 to 24hours, and turning off all appliances). Why does the EPA recommend colleting air samples during a non-typical condition? In our opinion, the criterion recommended by the EPA alters a residential structure's typical ventilation rate, probably reduces it, and therefore biases the sample result such that the rate of vapor intrusion and resulting chemical concentration are atypical of an occupied condition.

The Draft Guidance's recommendation is consistent with recommendations made by the Massachusetts Department of Environmental Protection.[8] In our opinion, this assumption is fundamentally flawed and unnecessarily increases the risk to residential occupants by under-predicting possible chemical exposure.

Also on Page E-5, the Draft Guidance recommends multiple simultaneous samples collected during each sampling event, enhanced use of blanks, and special attention to be paid to quality control measures. These recommendations are acceptable because many air sampling programs reviewed by the author fail to adequately characterize indoor air contamination due to omissions relevant to these factors; mostly due to cost considerations. In order to mitigate some of the cost issues associated with collecting multiple samples, the Draft Guidance should recommend sampling during a mechanically induced structure depressurization condition. This imparts a worst-case condition on the structure, and usually enhances the rate of vapor intrusion through the building envelope.

Page E-7 of the Draft Guidance recommends drilling holes through the foundation to sample soil-gas immediately below the foundation. While this approach may provide some useful data with respect to concentrations of chemical vapors immediately under the foundation, it is not without consequences. Why punch holes in a perfectly good foundation, thereby providing additional pathways for vapor intrusion? The suggestion that holes can be adequately sealed with "tape or pliable caulk" is very shortsighted on the part of the EPA. From our perspective, a caulk, sealer, or foam is nothing more than a temporary plug to a permanent hole. Has the EPA considered the long-term ramifications of this recommendation? Does the EPA recognize that holes sealed in this manner require maintenance in order to remain sealed? These are yet further examples of the Draft Guidance use of scientific approach that fails to consider the science of construction.

Opinion

Based on the author's experience in investigating numerous structures for chemical vapor intrusion, there appear to be three significant factors that control this phenomenon: source, force, and pathway. The analogy of the fire-triangle would be useful: oxygen, heat, and fuel help to describe vapor intrusion criteria. On many projects, we have observed that if any one

of the three (vapor intrusion) factors can be engineered away, vapor intrusion through the building envelope will be mitigated. The Draft Guidance assumes a source, and attempts to predict the pathway, on which we have already commented. However, it appears that more study is warranted regarding the factor of force. Considering this factor for a moment: the relevant physical process that significantly influences vapor migration includes, in this order: advective, convective, and (to a minor extent) diffusive forces. This belief is consistent with observations made in the field, and with most vapor intrusion models.

References

1. *Heuristic Model for Predicting the Intrusion Rate of Contaminated Vapors into Buildings*, P.C. Johnson and R.A. Ettinger. Environmental Science and Technology (1991). Vol. 25, No. 8, 1445-1452

2. ASTM E1739-95 – American Society of Testing and Materials Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.

3. Indoor Air Inhalation Investigation Panel Michigan Environmental Science Board. Meeting Summary. June 19, 2000

4. *Estimating Residential Indoor Air Impacts Due to Groundwater Contamination*, D. Kruz, Proceeding on the 2000 Conference on Hazardous Waste Research.

5. *Overview of Goergetown Community of the Status of the Philip Service Corp. Site – Executive Summary*. City of Seattle. April 19, 2002

6. *Soil and Groundwater to Indoor Pathway Evaluation for Risk Assessment at Commercial/Industrial Properties: A Comparison of Model Derived Risks with Soil Vapor*, E. M. Cherry, et al. The Annual International Conference on Contaminated Soils, Sediments and Water. 2001

7. *Groundwater to Indoor Air – The Exposure Pathway of the Future*. D.L. Thompson, et al. The Annual International Conference on Contaminated Soils, Sediments and Water. 2002

8. *Indoor Air Sampling and Evaluation Guide (April 2002)*, Massachusetts Department of Environmental Protection, WSC Policy No. 02-430